Electronic Version
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Claims

[c1] 1. A method for refining both a vertex distribution and a mesh of elements for an object to be analyzed, using a computerized device, comprising the steps of:
searching for a set of terminal-edges among target elements of said mesh, using a longest edge searching method;
inserting at least one selected point associated with at least one of said terminal-edges into said mesh producing a refined mesh; and
displaying information related to said mesh; wherein:
each said terminal-edge is defined as a common longest-edge of each said mesh element sharing said terminal-edge.

[c2] 2. The method of claim 1, for also improving in addition to refining said vertex distribution and said mesh of elements, comprising the steps of:
selecting a set of boundary points associated with said element if said element belongs to boundary elements included among said target elements using a longest-edge boundary selection method; and
inserting said selected boundary points into said mesh;

and actualizing set of target elements of said mesh.

[c3] The method of claim 1, wherein said step of using said longest edge searching method comprises the further step of:
for a processing element from a set of processing elements, producing an increased set selected from the group consisting of said set of processing elements, and said set of terminal edges, comprising the steps of:
selecting a selected edge which is a longest-edge between the edges of said processing element;
finding active elements in mesh having said selected edge as an edge and whose respective longest-edge is greater than said selected edge, and adding said active elements to said set of processing elements; and
if said active elements are not found, selecting said selected edge as a terminal edge.

[c4] 4. The method of claim 2, wherein said step of using said longest edge searching method comprises the further steps of:
for a processing element from a set of processing elements, producing an increased set selected from the group consisting of said set of processing elements, and said set of terminal edges, comprising the steps of:
selecting a selected edge which is a longest-edge between the edges of said processing element;

finding active elements in mesh having said selected edge as an edge and whose respective longest-edge is greater than said selected edge, and adding said active elements to said set of processing elements;
if said active elements are not found, selecting said selected edge as a terminal edge.

[c5] 5. The method of claim 2, further comprising the steps of:
identifying a prospective point as a midpoint of a greatest edge between the edges of elements within said set of terminal-edges;
choosing said prospective point to be one of said selected points to be inserted into said mesh, said selected point in said object interior, thereby producing said improved mesh, if the distance from said prospective point to said object boundary is greater than a fraction K of the length of said greatest edge, wherein K is a parameter greater than zero; and
otherwise choosing one of said selected points to be inserted into said mesh as a boundary point improving the boundary point distribution near to an auxiliary boundary point, wherein said auxiliary boundary point is equal to said prospective point when said prospective point is over the boundary, and wherein said auxiliary boundary point is otherwise equal to the projection of said

prospective point over the boundary.

[c6] 6. The method of claim 1, further comprising the steps of:
selecting midpoints of said associated terminal-edges as said selected points; and
inserting said selected points into said mesh by performing longest-edge bisection of each element in said mesh sharing said associated terminal-edge.

[c7] 7. The method of claim 1, for use when said computerized device comprises at least one parallel processor, further comprising the further step of:
producing a refined mesh by successive parallel refinement of sets of completely disjoint terminal-element-sets; and
refining each said terminal-element-set by partitioning each element in said terminal-element-set by a midpoint of a common associated terminal-edge.

[c8] 8. The method of claim 1, for also derefining in addition to refining said vertex distribution and said mesh of elements, comprising the further steps, for an initial mesh previously obtained by said steps of searching and inserting, of:
for at least one target vertex to be derefined in said mesh, producing a set of active vertices, each said active

vertex having an associated vertex indicator of precedence order between neighbor vertices in the mesh generation process, and an associated generator-edge if said vertex was obtained in a previous mesh as a midpoint of said terminal-edge defining an associated generator-edge for said vertex;

eliminating from said mesh said active vertices in the inverse order of precedence defined in the mesh generation process by using said associated vertex indicators, and for vertices having equal vertex indicators, in increasing order of the lengths of said associated generator-edges; wherein each active vertex is directly connected with the vertices of said associated generator edge;and

adding to said mesh a new edge equal to the generator-edge of said vertex, and new elements sharing said edge.

[c9] 9. A computerized device for refining both a vertex distribution and a mesh of elements for an object to be analyzed, comprising processing, input, output, and storage devices providing means for:

searching for a set of terminal-edges among target elements of said mesh, using a longest edge searching method;

inserting at least one selected point associated with at

least one of said terminal-edges into said mesh producing a refined mesh; and
displaying information related to said mesh; wherein:
each said terminal-edge is defined as a common longest-edge of each said mesh element sharing said terminal-edge.

[c10] 10. The computerized device of claim 9, for also improving in addition to refining said vertex distribution and said mesh of elements, said processing, input, output, and storage devices further comprising means for:
selecting a set of boundary points associated with said element if said element belongs to boundary elements included among said target elements using a longest-edge boundary selection method; and
inserting said selected boundary points into said mesh; and actualizing set of target elements of said mesh.

[c11] 11. The computerized device of claim 9, said processing, input, output, and storage devices further comprising means for:
for a processing element from a set of processing elements, producing an increased set selected from the group consisting of said set of processing elements, and said set of terminal edges, comprising means, by:
selecting a selected edge which is a longest-edge between the edges of said processing element;

finding active elements in mesh having said selected edge as an edge and whose respective longest-edge is greater than said selected edge, and adding said active elements to said set of processing elements; and
if said active elements are not found, selecting said selected edge as a terminal edge.

[c12] 12. The computerized device of claim 10, said processing, input, output, and storage devices further comprising means for:
for a processing element from a set of processing elements, producing an increased set selected from the group consisting of said set of processing elements, and said set of terminal edges, comprising means, by:
selecting a selected edge which is a longest-edge between the edges of said processing element;
finding active elements in mesh having said selected edge as an edge and whose respective longest-edge is greater than said selected edge, and adding said active elements to said set of processing elements; and
if said active elements are not found, selecting said selected edge as a terminal edge.

[c13] 13. The computerized device of claim 10, said processing, input, output, and storage devices further comprising means for:
identifying a prospective point as a midpoint of a great-

est edge between the edges of elements within said set of terminal-edges;

choosing said prospective point to be one of said selected points to be inserted into said mesh, said selected point in said object interior, thereby producing said improved mesh, if the distance from said prospective point to said object boundary is greater than a fraction K of the length of said greatest edge, wherein K is a parameter greater than zero; and

otherwise choosing one of said selected points to be inserted into said mesh as a boundary point improving the boundary point distribution near to an auxiliary boundary point, wherein said auxiliary boundary point is equal to said prospective point when said prospective point is over the boundary, and wherein said auxiliary boundary point is otherwise equal to the projection of said prospective point over the boundary.

[c14] 14. The computerized device of claim 9, said processing, input, output, and storage devices further comprising means for:

selecting midpoints of said associated terminal-edges as said selected points; and

inserting said selected points into said mesh by performing longest-edge bisection of each element in said mesh sharing said associated terminal-edge.

[c15] 15. The computerized device of claim 9, said processing device thereof comprising at least one parallel processor, said processing, input, output, and storage devices further comprising means, for:
producing a refined mesh by successive parallel refinement of a set of completely disjoint terminal-element-sets; and
refining each said terminal-element-set by partitioning each element in said terminal-element-set by a midpoint of a common associated terminal-edge.

[c16] 16. The computerized device of claim 9, for also derefining in addition to refining said vertex distribution and said mesh of elements, said processing, input, output, and storage devices further comprising means, for an initial mesh previously obtained by said searching and inserting, for:
for at least one target vertex to be derefined in said mesh, producing a set of active vertices, each said active vertex having an associated vertex indicator of precedence order between neighbor vertices in the mesh generation process, and an associated generator-edge if said vertex was obtained in a previous mesh as a midpoint of said terminal-edge defining an associated generator-edge for said vertex;
eliminating from said mesh said active vertices in the in-

verse order of precedence defined in the mesh generation process by using said associated vertex indicators, and for vertices having equal vertex indicators, in increasing order of the lengths of said associated generator-edges; wherein each active vertex is directly connected with the vertices of said associated generator edges;and

adding to said mesh a new edge equal to the generator-edge of said vertex, and new elements sharing said edge.

[c17] 17. A data structure stored and processed by a computerized device for both refining, improving or derefining or both a vertex distribution and a mesh of elements for an object to be analyzed, comprising:

an edge representation comprising at least one represented edge, and for each said represented edge, comprising references to neighbor elements in an element representation of said data structure, each said neighbor element having said represented edge which is an edge of said mesh as one of its edges;

a vertex representation, for each represented vertex, comprising an associated indicator which is null, if said vertex was not obtained as a midpoint of a terminal-edge in a previous mesh; otherwise, said associated indicator being equal to the following precedence indicator

value associated to the last generated vertex between the two vertices defining a terminal-edge in a previous mesh; and

a reference to a generator edge for said vertex in a generator-edge representation of said mesh; wherein:

said terminal-edge is defined as said generator-edge of said vertex; and

information related to said mesh is displayed.